Viral Hemorrhagic Septicemia
Past, Present and Future

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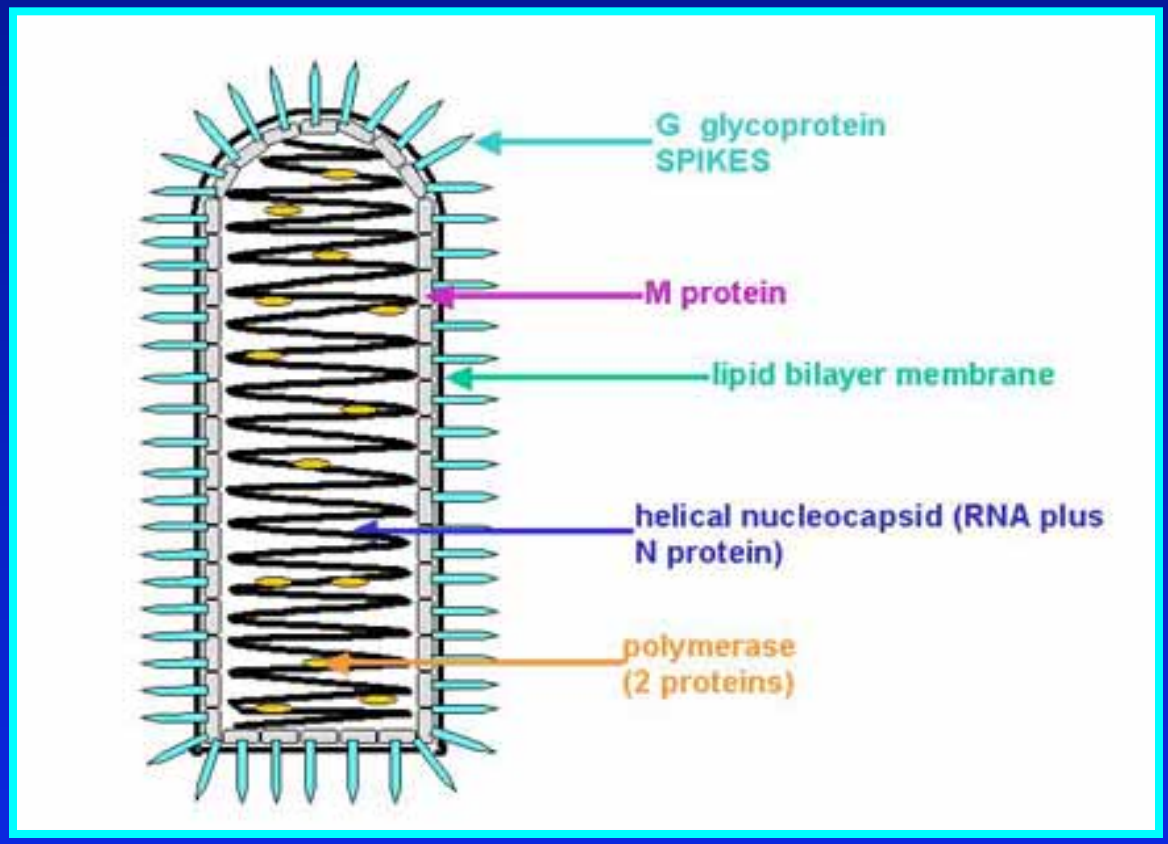
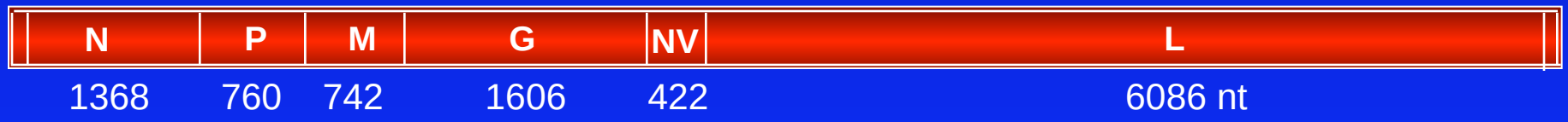
Viral Hemorrhagic Septicemia Virus





Negative-sense, single-stranded RNA genome of 11,158 nucleotides
Six genes coding for 5 structural and 1 non-structural (NV) protein

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Part I: VHS discovered in Europe

- Disease in rainbow trout described by Schaperclaus (1938)
- Evidence for filterable agent (virus) in 1950s
- Virus first isolated in Denmark by Jensen (1963)
- Established cell lines and diagnostic antisera developed
- Virus found in increasing number of freshwater species
- Experimental testing of host range

Virus known until late 1980's as an endemic pathogen of freshwater fish in western Europe that mostly affected rainbow trout, an introduced species

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Rainbow trout with VHS

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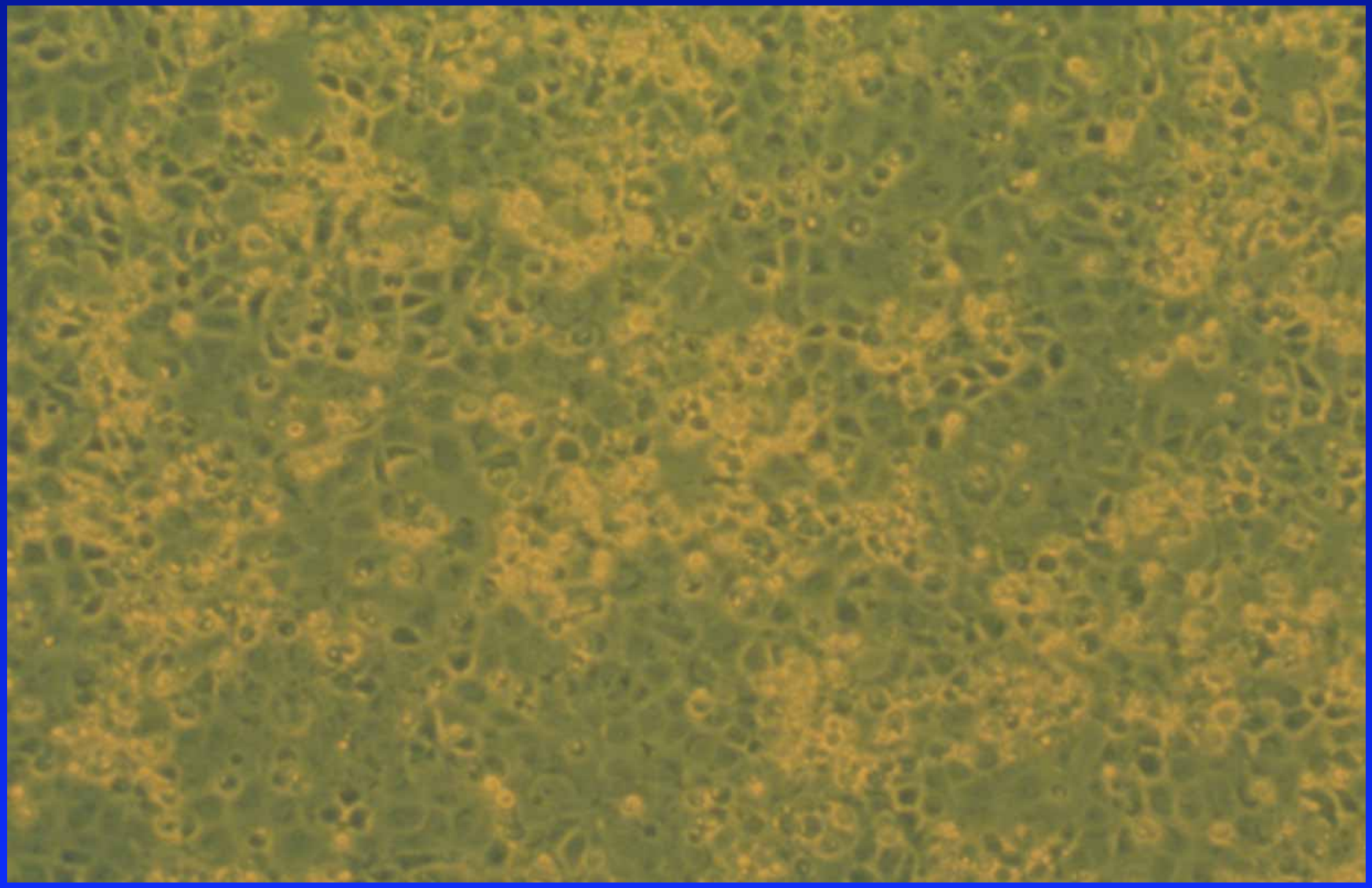
Culture of fish cell line infected with VHSV



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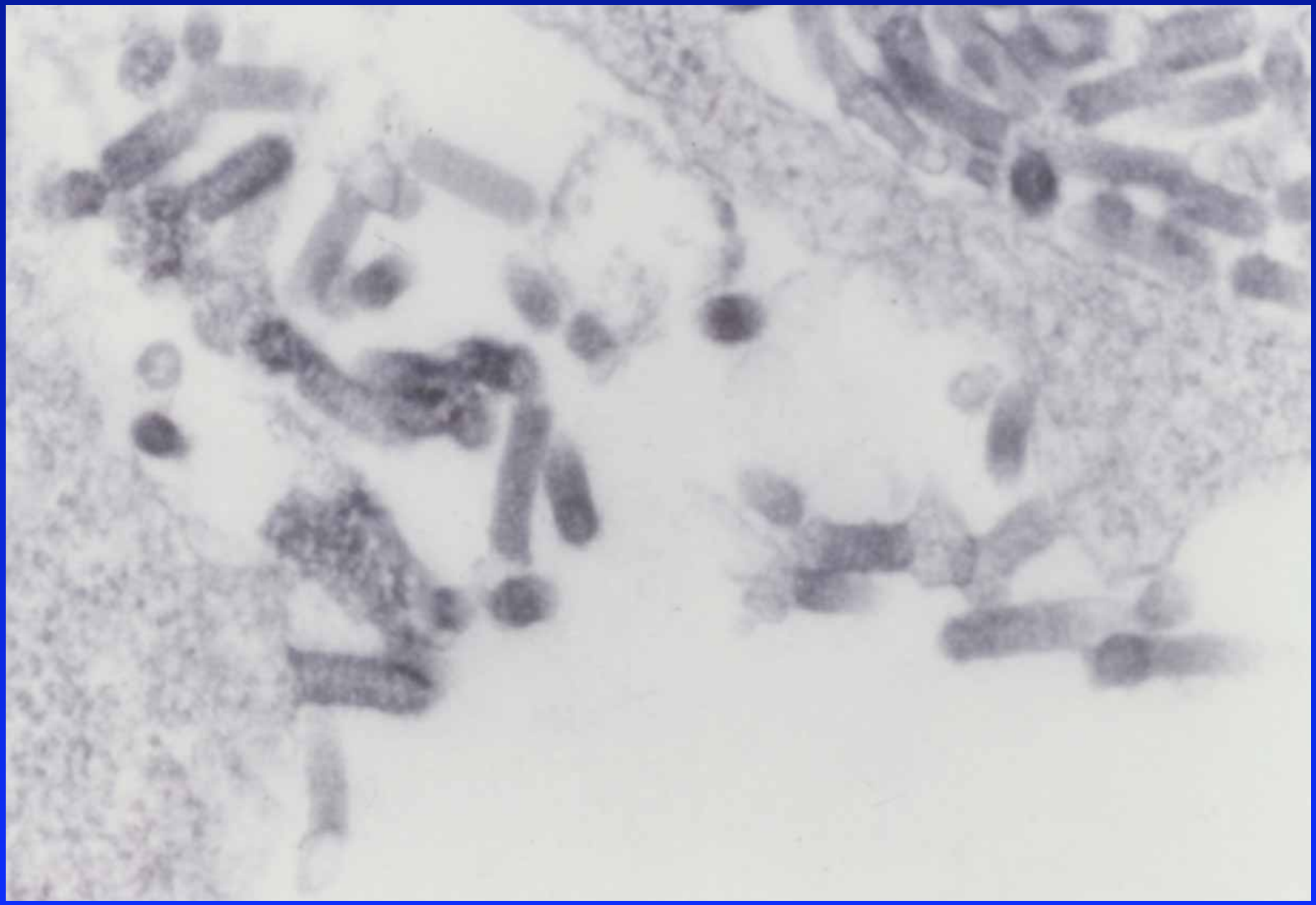
Electron micrograph of VHSV particles budding from infected cells



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Part II: VHS found in the Pacific and Atlantic Oceans

- VHSV isolated in 1988 from normal adult salmon in Washington returning from Pacific Ocean - First report from North America
- North American isolates were genetically distinct and less virulent for salmon or trout, but highly pathogenic for marine species
- Surveys showed VHSV widespread among wild marine fish in North Pacific and North Atlantic Oceans - Natural outbreaks seen
- Geographic range included west coast of North America, North Sea, Baltic Sea, North Atlantic and waters around Japan

Until 2005, VHSV thought to be mainly a pathogen of marine fish in North Atlantic and North Pacific Oceans that was introduced to trout farms in Europe via feeding of raw marine fish (e.g. herring), where it adapted over time to become more virulent for trout

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Wild sardines dying in the Pacific Ocean near Port Hardy, B.C., Canada

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Part III: VHS found on the east coast of North America and in the Great Lakes

- 2000-2004 VHSV isolated from mummichog, 3-spined stickleback, striped bass and sea-run brown trout from coastal areas of New Brunswick, Canada
- 2003 - Virus isolated from diseased muskellunge in Lake St Clair shown to be VHSV - Earliest known isolate from Great Lakes
- 2005 - VHSV isolated from large outbreak among freshwater drum and other species in Lake Ontario
- 2006 to present - VHSV spreads to an increasing number of locations and species in the Great Lakes Basin with high mortality in muskellunge, yellow perch and freshwater drum

A strain of VHSV is now shown to be a significant pathogen of natural populations of free-ranging fish in fresh or brackish water

2005 Mortality Events

Example: 40,000 Freshwater Drum dead in 4 days

Lake Huron

ke Ontario

Lake Superio

Lake M

Erie

www.coastwatch.msu.edu

Eye of a muskellunge - Small hemorrhages

Muskellunge swimbladder - Fluid-filled vesicles

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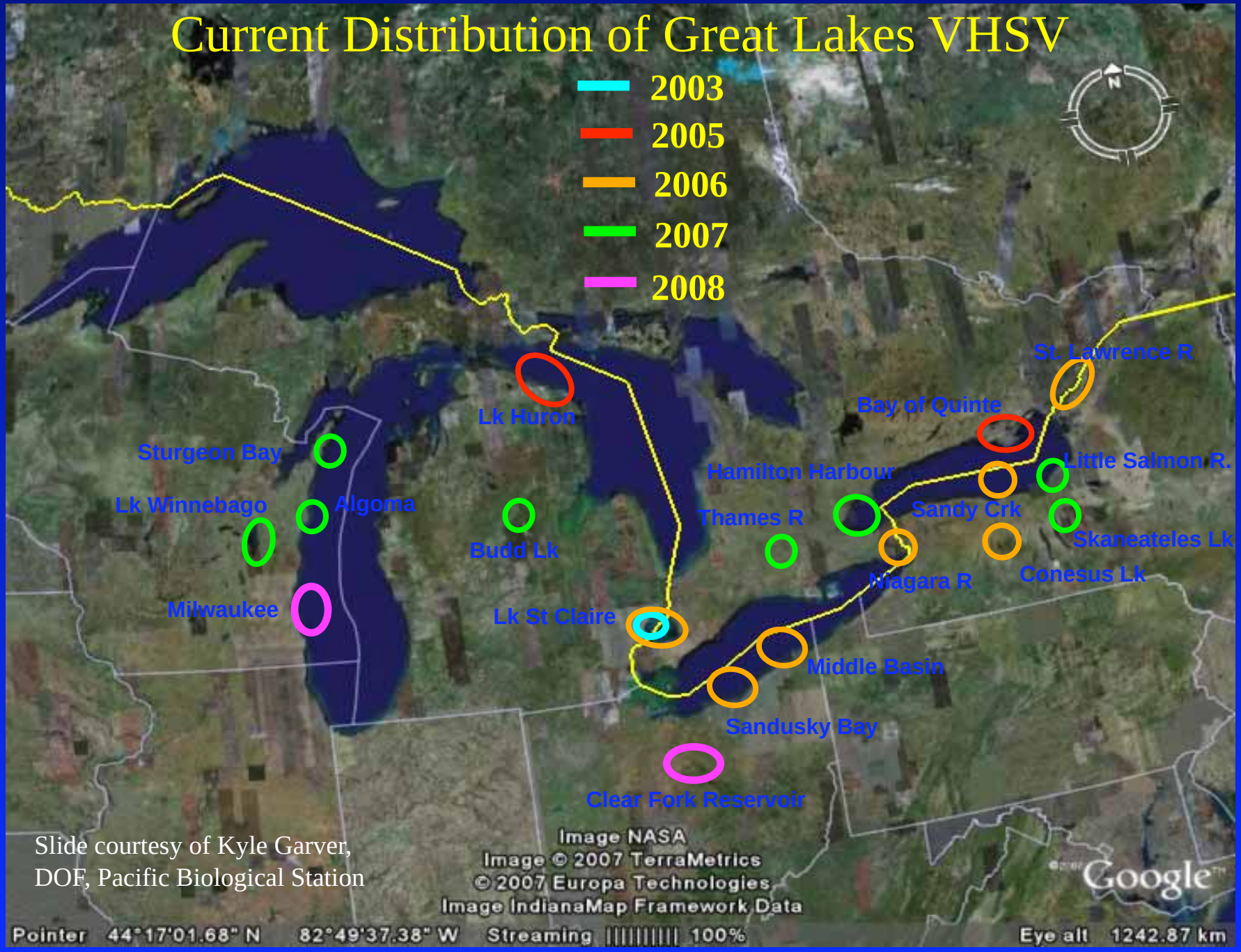
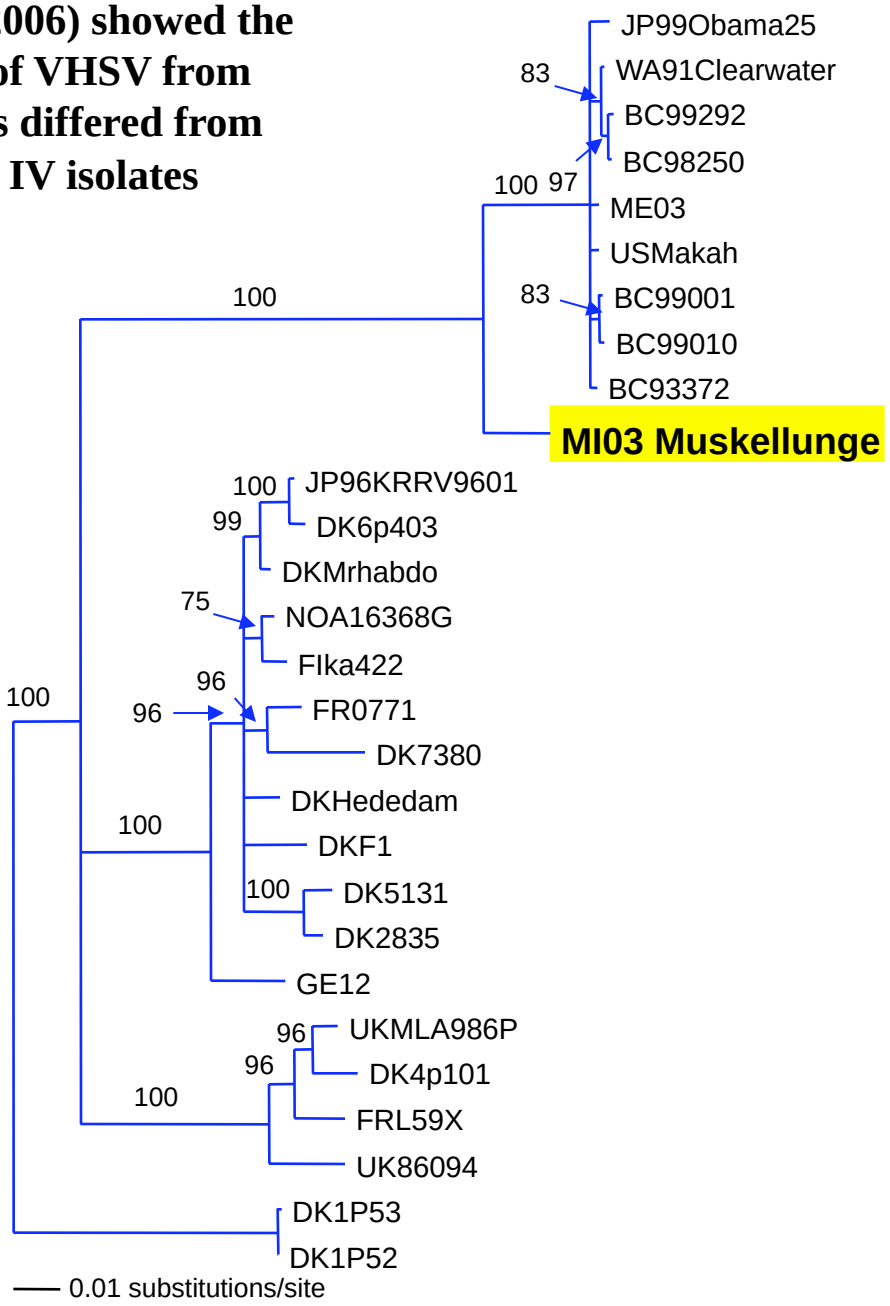
Gizzard shad - Note widespread hemorrhages

Current Distribution of Great Lakes VHSV



Slide courtesy of Kyle Garver,
DOF, Pacific Biological Station

Elsayed et al. (2006) showed the Muskie isolate of VHSV from the Great Lakes differed from other Genotype IV isolates



IVa
IVb
Ib
Id
Ia
Ic
Ie
III
II

North America and Japan

Europe

United Kingdom

North Sea and Baltic

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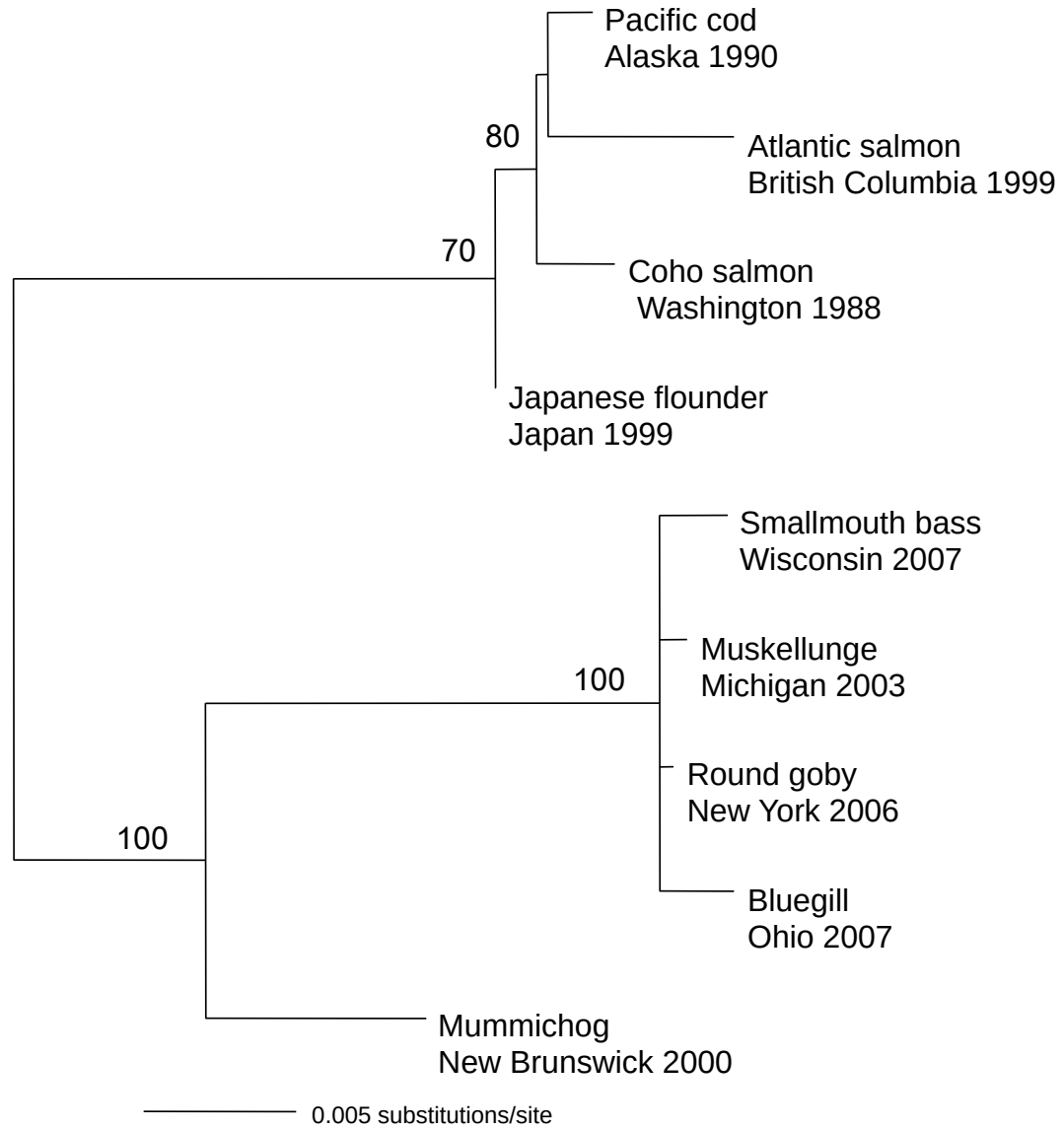

West Coast IVa

Great Lakes East coast IVb

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VHS Research at the USGS

1. The USGS Western Fisheries Research Center (WFRC) is an international center of expertise
2. WFRC collaborates internationally with agriculture agencies
3. The WFRC provides immediate and critical advice
4. WFRC conducted tactical research
5. The WFRC developed an Integrated Research Plan
6. Upper Midwest Environmental Research Center (LaCrosse) tested egg disinfection methods

VHS Research at the USGS

7. Molecular epidemiology has shown:
   - All Great Lakes VHSV isolates identical
   - Low genetic diversity suggests a recent, single, introduction
   - The isolates from the Great Lakes are closely related to Atlantic strain
   - One, large, multi-year, disease outbreak involving many species of fish

Predictions for the Future

- Virus will persist, outbreaks will occur - esp. late spring
- Large differences in susceptibility among species
- Population-level effects for some species
- Survivors will be immune
- The virus may adapt and become more diverse over time
- Stressors will exacerbate latent infections and disease
- Disease will move toward younger age classes

Work Planned for Next Year

1. Technical assistance and advice to fisheries agencies
2. Complete development of web-based VHS database
3. Continue epidemiological analysis of new isolates
4. Initiate studies to determine
    a. the role of temperature on disease
    b. the nature of the immune response
    c. the nature of the carrier state
    d. the factors controlling disease

An Integrated Research Program on VHS

1. Improve Surveillance - Host and Geographic Range
2. Biosecurity for Aquaculture
3. Improved Diagnostics
4. Genetic Typing and Epidemiology
5. Development Laboratory Challenge Model(s)
6. Test Host Range of VHSV IVb
7. Epidemiology and Disease Ecology
8. Effect of Temperature on Infection
9. Effects of Other Environmental and Physiological Conditions
10. Ability of VHSV IVb to Adapt to Other Hosts
11. Characterize Immune Response
12. Development and Testing of Candidate Vaccines
13. Research in Support of Policy Development


Thank
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Freshwater Fishing Hall of Fame,
Wisconsin
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